Control of Invasive Woody Species

SESSION CHAIR: VHALINAVHO P KHAVHAGALI

Tuesday, 20 July 2010, 16:00-17:00

Platform & Poster Presentations

POSTER PRESENTATION: AN EXPERT SYSTEM FOR BUSH ENCROACHMENT IN NAMIBIA

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An online expert system for rangeland management was developed for semiarid savannas in central Namibia, with particular emphasis on encroachment by *Acacia mellifera* subsp. *detinens*. The Expert System consists of 21 questions and 22 decisions.

Decisions are divided into three types: adaptive, reactive and ongoing good management. Adaptive decisions are related to seasons of high rainfall, as this is a critical window both in terms of a hazard (transition to bushy thickened state if no fire is applied) and opportunity (transition back to an open savanna if fire is applied). Reactive decisions (or symptom treatment) refer to ways in which existing bush thicket problems occur. The Expert System should be applied to different camps, and used three times a year (hot wet season, cold dry season and cold wet season).

The questions require mostly qualitative "high"/"medium"/"low" and "yes"/"no" answers. This is because absolute thresholds are complex and not yet determined, and farmers often have their own perception of what constitutes "bush encroachment". The Expert System uses wiki technology (as is used for wikipedia, for example), which allows a high level of interaction between user and administrator. It has embedded links to explanations, photographs and additional information. An additional booklet has also been developed, because computer and internet access is still mostly limited to established commercial farmers, and internet bandwidth is limited. Both the online and the booklet versions have an easy-to-follow one page decision tree for easy reference in the field. The decision pathway is represented as in a dichotomous key.

During the Expert System's development we held workshops with farmers. Their comments were incorporated into the Expert System. The System is flexible and we expect it to change as research results and farmers' expert knowledge is forthcoming. We envisage similar approaches to be developed, and possibly incorporated into ours, for other species and other conditions (for example, for *Dichrostachys cinerea* and for woody plant encroachment in higher rainfall areas).

Workshops are planned where extension staff of the Ministry of Agriculture, Water and Forestry will be introduced to and trained in the use of the system. Staff will hopefully disseminate it to farmers. The Expert System is useful to enhance dialogue between farmers and extension officers, as well as among farmers in farmer's study groups. Acceptance and use of the expert system by a relatively unconnected wider community (such as a rangeland management community) is seen as an important challenge. Our workshops show that farmer decisions for the same management scenarios are very varied. Also, most farmers are very focussed on reactive decision making, although bush encroachment initiation events (rare events) have occurred in this decade. Expert systems have an important role to play in improving rangeland management in Namibia, provided challenges are met.

The poster describes the Expert System, and highlights important aspects of its development and the way forward.

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PLATFORM PRESENTATION: AN EVALUATION OF THE EFFECTIVENESS OF MECHANICAL BUSH THINNING IN MARAKELE PARK, LIMPOPO PROVINCE

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Bush encroachment is a major problem in the semi-arid savannas of South Africa and is of increased concern in nature conservation areas such as Marakele Park, Limpopo Province. A mechanical bush thinning programme was implemented during 2002/03. However, concerns were raised regarding the effectiveness of the applied tree thinning method. The objective of the study was to determine whether the mechanical bush thinning programme was successful in reducing woody plant density as well as the potential competitiveness of the woody layer.

The study was conducted in Marakele Park, Limpopo Province (24°15´ to 24°35´S, and 27°27´ to 27°47´E) with an annual rainfall that varies between 350 mm to 650 mm. Three vegetation types based on the dominant species were identified: *Acacia mellifera - Grewia flava* (Am-GF), *Combretum apiculatum - G. flava* (Ca-GF), *A. erubescens - Dichrostachys cinerea* (Ae-Dc). Two experimental plots (100 m x 200 m) were demarcated in each vegetation type, one each in a thinned (Treatment) and an untreated (Control). Two additional thinned plots (without control plots) in the Ca-GF and Am-Gf vegetation types were included to evaluate coppicing ability. The woody layer of each plot was quantified in terms of Evapotranspiration Tree Equivalents (ETTE).ha^{-1} (Smit 1989) during the 2003/04 and 2004/05 seasons; and grouped into Normal and Coppiced plants.

The *A. mellifera* dominated plots had the highest total ETTE.ha^{-1}, with values exceeding 10000 ETTE.ha^{-1}. Relatively small differences in ETTE.ha^{-1} were found between control and corresponding treatment plots, and differences rapidly declined with each season (Table 1). In the Am-Gf Treatment plots (combined), a total of 27480 *A. mellifera* seedlings.ha^{-1} were counted.

Table 1: The ETTE.ha^{-1} of each experimental plot during the 2003/04 and 2004/05 seasons. ((T) – treatment plot, (C) – control plot, (Cop) – coppice plot)

Plot	ETTE.ha^{-1} - 2003/04			ETTE.ha^{-1} - 2004/05		
	Normal	Coppice	Total	Normal	Coppice	Total
Am-Gf (T)	8 243	206	8 449	-	448	8 691
Am-Gf (C)	10 331	-	10 331	-	-	10 331
Ca-Gf (T)	3 403	350	3 753	-	1 148	4 551
Ca-Gf (C)	7 799	-	7 799	-	-	7 799
Ae-Dc (T)	3 381	747	4 128	-	947	4 328
Ae-Dc (C)	8 676	-	8 676	-	-	8 676
Ca-Gf (Cop)	4 348	892	5 240	-	2 660	7 008
Am-Gf (Cop)	9 676	1 240	10 916	-	3 974	13 650

The mechanical bush thinning method used in Marakele Park is considered not to be successful. This was due to the unselective manner of the tree thinning procedure, soil disturbances, vigorous coppicing of the cut plants, and the establishment of new seedlings that have effectively neutralised the expected effect of the thinning treatments. With no follow-up treatments, either chemical or mechanical, the objective to increase herbaceous dry matter yield was not met. The bush encroachment problem may ultimately be worse than before the initial treatment. Overgrazing was also identified as contributing to the bush encroachment problem in the study area.

References:

Smit, G.N. 1989. Quantitative description of woody plant communities: Part I. An approach. *Journal of the Grassland Society of Southern Africa* 6: 186-191.

NOTES:

POSTER PRESENTATION: IMPACT OF MESQUITE (*PROSOPIS SPP*) INVASION AND CLEARING ON THE GRAZING CAPACITY OF SEMI-ARID NAMA KAROO RANGELAND, SOUTH AFRICA

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There is considerable concern in South Africa over the impact of invasive alien plants (IAPs) on rangeland productivity. IAPs cover an estimated 8% (10 million ha) of the country and are expanding at a rate of 5% per year. Much of the affected land is natural rangeland. One IAP which has received attention is the leguminous tree, mesquite (*Prosopis spp.*), which is estimated to cover at least 18000 km^2 of the Nama Karoo's low lying alluvial plains and seasonal watercourses. Mesquite, which occurs in many places as thickets, is thought to have greatly reduced the productivity of invaded rangeland by displacing natural forage species.

Large areas in the Nama Karoo have been cleared of mesquite under a government-led IAP control programme called Working for Water. These clearings are expected to deliver long-term socio-economic benefits to affected areas through increased water supply and agricultural productivity. While there is considerable scientific evidence to support the expectation of future water supply benefits, there is a paucity of data on impacts on rangeland productivity.

We quantified the impact of mesquite invasion and clearance on the grazing capacity of degraded Nama Karoo rangeland in the Beaufort West district of the Western Cape Province of South Africa. Grazing capacity values were estimated using the grazing index method. Our data reveal that mesquite invasion reduces grazing capacity while clearing improves it (Fig. 1). The decline in grazing capacity due to mesquite invasion is associated with decreases in the abundance of grass species. Invading mesquite contribute positively to rangeland grazing capacity, but not to levels that counteract the overall decline in grazing capacity during invasion. The increase after clearing is driven by increases in the abundance of grass and non-succulent shrub species. The magnitude of the decline in grazing capacity due to mesquite invasion increases with the intensity of infestation (Fig. 2).

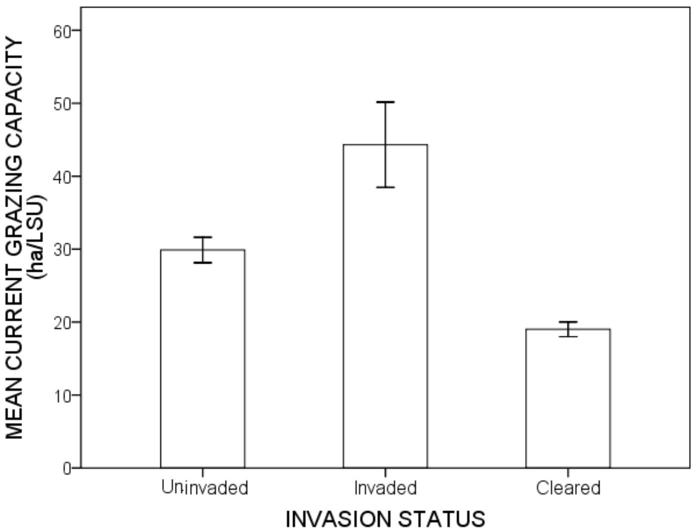

Figure 1: Comparison of mean current grazing capacities for uninvaded (n =5), invaded (n=2) and cleared (n=3) sites. The error bars are times one standard error. All differences are significant at $p \leq 0.05$ (Kruskal Wallis H = 37.38 followed by Mann-Whitney pair-wise tests).

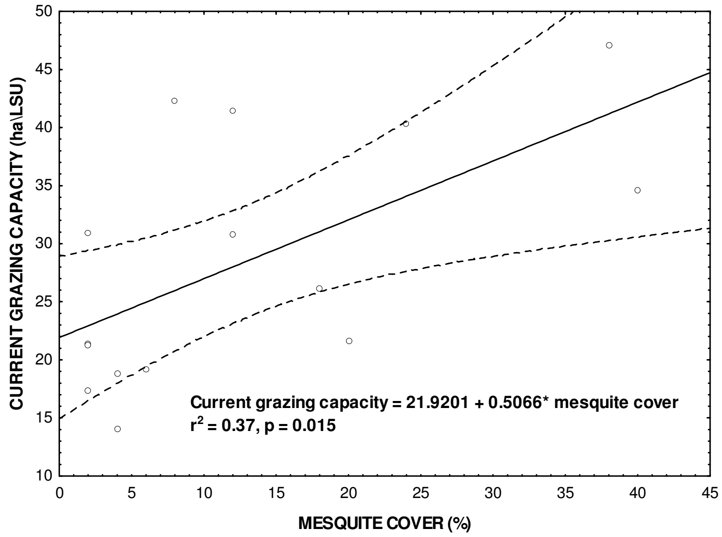

Figure 2: Relationship between mesquite cover and current grazing capacity. Also shown is the regression equation, coefficient of determination (r^2), and 95% confidence intervals. The regression is positive but the effects of mesquite on the grazing capacity are negative because the ordinate (y axis) is expressed in $ha.LSU^{-1}$ and not $LSU.ha^{-1}$.

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PLATFORM PRESENTATION: THE EFFECTS OF CAMEL (CAMELUS DROMEDARIES) BROWSING ON ACACIA KARROO TREE ENCROACHMENT IN THE EASTERN CAPE PROVINCE THORNVELD

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The increase of livestock producing farming areas covered by woody vegetation is a common problem well documented in Australia. A combination of fire and goats has been the recommended strategy to control bush encroachment in Southern Africa. The effect of controlling bush encroachment using camels is unknown in the Eastern Cape Province of South Africa, which is predominantly encroached by *A. karroo* trees. It is reported that camels flourish on a wide variety of *Acacia* species. Camels prefer to spend 90% of time browsing and only 10% grazing. The introduction of camels to the Clifford farm close to Stutterheim early in 2006 was solely to control *A. karroo* encroachment specifically on old lands, where extremely dense stands occurred. At the time camel impact on *A. karroo* trees were unknown. Other factors such as management guidelines and carrying capacity for camels were also not clear.

A study was conducted at the Clifford farm, 30 km. from Stutterheim. The veld type for the area is classified as Eastern Cape Thornveld. The study site consisted of an old land previously used for cultivation and now completely encroached by *A. karroo* trees, varying in size between seedlings smaller than 1m to trees approximately 2 m in height. The long-term annual rainfall for the area is 600 mm.

An area of two hectares was fenced for the project. Within the enclosed area, two 25 m x 50 m control plots were erected and fenced in. The Camel browsing treatment is applied in the remainder of the area. Between 6 and 8 Camels are introduced as browsers to the treatment area twice during the growing season, once in spring and once in autumn. The trial grazing strategy for the two grazing periods during the season is, one early after the *A. karroo* trees has completed the new seasons flush growth, and the second towards the end of the growing season as trees prepare to conserve energy reserves for the new seasons growth the following year after the winter period.

The browsing impact is monitored on a weekly basis and animals are removed after removal of leave volume exceeds 50%. The introduction and removal of animals are determined by visual appraisals conducted by the researcher and or farmer. Animal condition are also considered and monitored throughout. Surveys (6 in the control and 5 in the treatment sites) before and after browsing periods are conducted on permanently marked fixed belt transects (30 m x 3 m). Vegetation is monitored along transects using the line intercept method. Along transects, each woody individual is identified and the tree height, canopy height, height of lowest browseable material, canopy diameter and number of stems are recorded. The survey data is used to assess any woody vegetation changes to plant structure and volume because of the treatment applied. The response variables analysed includes height and bush density of treatment compared to that of control plots. Analysis of variance is used to analyse the data.

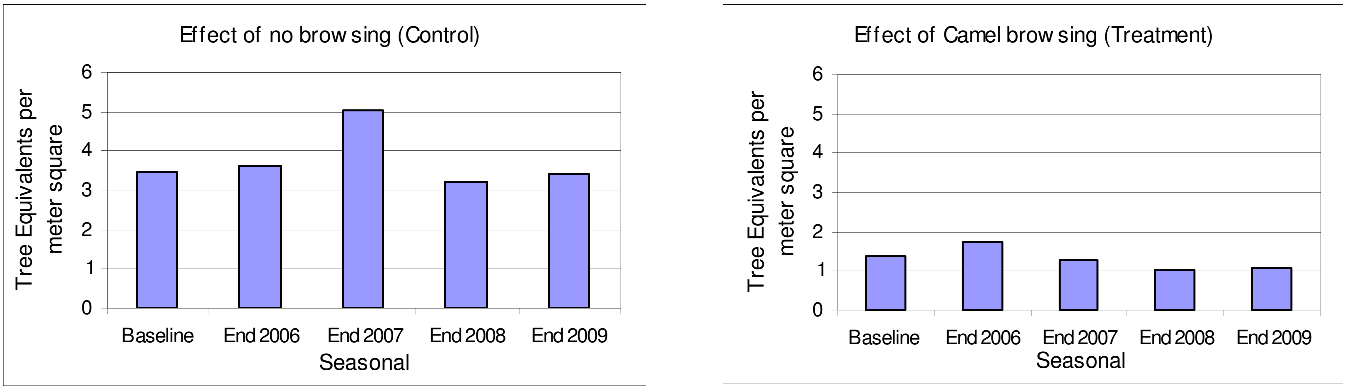

Figure 1: A graphical presentation comparing the effects of a camel browsing treatment to an unbrowsed control on the tree density volume over four seasons expressed in tree equivalents per square metre.

No significant difference was measured at the start of the trial but, the effect of the treatments applied had since resulted in various differences measured over time (last four years). Significant differences in the data sets were measured between the two treatments. These differences included tree height; canopy radius; canopy volume above 1.5 m; and tree equivalents per tree measured.

Although there is a consistent increase in tree density when *A. karroo* is not subjected to any form of browsing treatment (Figure 1), a definite decline in density was measured when trees were utilized with camels (Figure 1).

The control treatment (no-browsing) proved to have either static or consistent increases in tree density figures measured (Table 1). The introduction of camels to browse trees twice per season significantly reduced tree densities over a four year period. Tree canopy height slightly increased from 1.66 m to 1.74 m, camel browsing reduced total tree canopy volume from 0.68 to 0.53 per m^3. A dramatic reduction in trees per hectare from 9222.22 to 4466.67 trees, emphasize the significance camel browsing can have on *A. karroo* encroachment and control.

From the current results it can be concluded that camels can certainly play a very important part in the control and or eradication of bush encroachment and thickening specifically as far as *A. karroo* is concerned. Camels seem to have the ability to utilize a far larger portion of *A. karroo* trees than is possible for goats. They utilize trees at much higher and severe levels without showing signs of animal deterioration, and can therefore be used to put more pressure on bush encroachment than is currently possible for other domestic stock animals (goats). Camels utilize branch and leave, pressuring trees to recover under difficult circumstances. Although current results prove that camels have the ability to reduce tree numbers considerably per hectare, this reduction (more than half over a four year period), is still minor if the total trees per hectare is considered. This trial need to run as a long-term project, for the real effects to come to the fore. Tree density in the trial is currently still very high (4466.67 trees per hectare) and the tree survival system, has yet to crash.

Table 1: Average tree density figures from start of trial to end of 2009 season

Treatment	Season	Tree canopy height (m)	Density (trees per hectare)	Tree canopy radius (m)	Tree canopy volume (m^3)	Browsable tree volume (m^3)
Baseline camels	Start 2006	1.66	9622.22	0.55	0.68	0.68
Camels	End 2006	1.71	8088.89	0.59	0.86	0.86
Camels	End 2007	1.70	4955.56	0.53	0.64	0.61
Camels	End 2008	1.68	5044.44	0.50	0.51	0.50
Camels	End 2009	1.74	4466.67	0.50	0.53	0.52
Baseline control	Start 2006	1.89	5611.11	0.74	1.72	1.37
Control	End 2006	2.04	4333.33	0.76	1.80	1.45
Control	End 2007	2.49	2833.33	0.84	2.51	1.80
Control	End 2008	2.27	3851.85	0.73	1.61	0.94
Control	End 2009	2.35	6407.41	0.74	1.70	1.09

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POSTER PRESENTATION: THE INFLUENCE OF TREE THINNING ON GRASS DRY MATTER YIELD, WITH AND WITHOUT GRAZING BY HERBIVORE GAME SPECIES IN THE MARAKELE PARK, SOUTH AFRICA

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In semi-arid savannas of South Africa bush encroachment results in the suppression of grasses and is of serious concern in Marakele Park. Mechanical tree thinning was applied during 2002/03, but concerns were raised regarding the effectiveness of this measure, especially in view of high numbers of grazing game species. The objective of the study was to quantify the effect of the tree thinning on grass dry matter (DM) yield in areas protected from and exposed to grazing.

The study was conducted in Marakele Park, Limpopo Province (24°15´ to 24°35´S, and 27°27´ to 27°47´E) with an annual rainfall that varies between 350 mm to 650 mm. Three vegetation types based on dominant species were identified: *Acacia mellifera - Grewia flava* (Am-Gf), *A. erubescens - Dichrostachys cinerea* (Ae-Dc), *Combretum apiculatum - G. flava* (Ca-Gf). Two experimental plots (100 x 200 m) were demarcated in each vegetation type, one each in a thinned (Treatment) and an untreated (Control) plot. Nine exclosures (1.8 x 1.8 m) were placed randomly in each plot and herbaceous yield measured by cutting (2004/05). The tree layer of the plots was quantified in terms of Evapotranspiration Tree Equivalents (ETTE) (Smit 1989).

In exposed areas the grass DM yields in the Treatment plots did not differ substantially from the Control plots (Table 1). This is confirmed by non-significant ($P>0.05$) relations between $ETTE.ha^{-1}$ and grass DM yield (Table 2). Higher DM yields were recorded in areas protected from grazing (Table 1). Differences between control and treatment plots were relatively small and the ineffectiveness of the tree thinning demonstrated by non-significant ($P>0.5$) relations (Table 2).

Annual grasses showed no specifc relation with tree density, but in the case of perennial grasses this relation was mostly positive, indicating that trees at these densities and in the absence of grazing, contributed positively to grass DM yield. This was mainly due to the association of *Panicum maximum* with tree canopies.

Table 1: Total grass DM yield in areas exposed and protected from grazing at the end of the 2004/05 growing season in the various experimental plots. T = treatment plot, C = control plot

Exp plot	Tree density ($ETTE.ha^{-1}$)	DM yield ($kg.ha^{-1}$) Exposed	DM yield ($kg.ha^{-1}$) Protected
Am-Gf (T)	8 691	1 055	2 662
Am-Gf (C)	10 331	1 357	2 068
Ca-Gf (T)	4 551	847	1 363
Ca-Gf (C)	7 799	891	1 216
Ae-Dc (T)	4 328	533	1 204
Ae-Dc (C)	8 676	1 067	1 237

Table 2: Regression analyses of DM yield of grasses in the areas exposed and protected from grazing (dependent variable) and $ETTE.ha^{-1}$ (independent variable). (ns = non-significant P>0.05)

Grasses	Regression equation	r		P
Exposed				
Annual	Y = 26.033 + 0.002309x	0.018		0.677 ns
Perennial	Y = 185.87 + 0.062170x	0.434		0.158 ns
Combined	Y = 201.77 + 0.102300x	0.442		0.149 ns
Protected				
Annual	Y = 141.96 + -0.01379x	-0.779		0.431 ns
Perennial	Y = -1854.0 + 0.37430x	0.959		0.183 ns
Combined	Y = -1690.4 + 1.27100x	0.906		0.278 ns

The objective of the initial tree thinning treatments to increase grass DM yield was not achieved. Tree densities of the treatment plots were still too high to have a significant effect on grass DM yields, partly due to re-encroachment. The high grazing pressure appears to have effectively neutralised the anticipated positive effect of the reduced competition from the woody layer. This emphasises the importance of conservative stocking rates during the implementation of restoration measures such as tree thinning.

References:

Smit, G.N. 1989. Quantitative description of woody plant communities: Part I. An approach. *Journal of the Grassland Society of Southern Africa* 6: 186-191.

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